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LANGUAGE AS A NON-FORMATIVE FACTOR IN COGNITIVE PERFORMANCE

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies for acceptance, a thesis entitled "Language as a non-formative factor in cognitive performance" submitted by Monica Mary Czartoryski in partial fulfillment of the requirements for the degree of Master of Education.

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ABSTRACT

A theory, stemming from Binet, Piaget and Lashley, was advanced to the effect that intellectual functioning was of a subconscious and nonverbal sort, and that its representation at the conscious level could be of a verbal or nonverbal sort. Furthermore, certain individuals, presumably because taciturn responses on their part were reinforced by taciturn parental models, preferred the nonverbal mode to the detriment of their performance in beginning reading. It was hypothesized that these individuals would be predominantly male, taciturn and easily conditioned, i.e. non-impulsive, and isolated exemplars were found who fell into this category. Clearly defined and orthogonally related verbal and nonverbal factors appeared in the factor analysis of the intercorrelations among tests given to a group of 51 grade one students, but the nonverbal factor was sustained by the performance of impulsive, talkative males, a finding which supported Kagan's position that impulsive males read less well than their reflective counterparts.

The theory at the root of this investigation was not supported and may refer only to intellectual functioning of a creative sort.

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CHAPTER I

INTRODUCTION

This investigation took its origin from three sources. Firstly, Roe (1963, p.133) has contended that the elementary school curriculum and the way it is taught have heavy verbal emphasis. Secondly, Wepman (1960) has devised what he labels an "operational model" of the central nervous system which indicates three levels of function, a reflex level, a perceptual level and a conceptual level. According to the model, reading can occur at the perceptual level, as well as copying printed stimuli and writing words presented aurally, all of which are common elementary grade activities. At this level, the organism can transmit percepts which leave their traces on the "memory bank" but have no meaning to the individual. This could explain the ability of some children to answer questions about their reading correctly, on the basis of recall rather than comprehension. Finally, Anderson (1967) has emphasized theorizing, logically implicit in which is the hypothesis that symbolic problem solving could be carried out in a subconscious, nonverbal way.

The possibility offers itself, accordingly, that certain children might perform poorly in beginning reading and yet be capable of solving problems which require the use of objects or pictures, and that a contrast class of children might be observed who perform well in beginning reading, presumably because they are attracted to words and are motivated to acquire symbol-sound connections, but are relatively unable to solve the aforementioned problems.

In view of the significant correlations reported between performance in beginning reading and in intelligence tests (Dechant, 1964, p.40, de Hirsch, 1966, p.32) and between standardized verbal and nonverbal tests (MacArthur and Elly, 1963), it was assumed that most children would perform at about the same level in tests of beginning reading and of concrete operations, and that, therefore, the number of children in each of the two groups would be relatively small.

However, information about the characteristics of children in these groups will be useful in helping teachers in later grades to explain incongruous performances by students. This is especially necessary in the case of the former group of poor readers into which a number of otherwise capable students might fall, to their immediate, and possibly permanent, detriment. Consequently, the present investigation attempts to isolate a nonverbal factor which is imperfectly related to a factor defined by tests of beginning reading, and to describe the attributes of individuals whose performance sustains this factor.

CHAPTER II

THEORY AND HYPOTHESES

As the child ages between birth and adolescence, he is increasingly able to solve problems which he had formerly failed to solve. Piaget (1965, p.31) puts these problems into logical groups or "basic structures", of which the most important sort is the construction of an elementary inductive logic.

> Thus there is an age (generally before 7-8 years) when the child does not recognize the transitive nature of equalities (A = C admitted deductively if the subject has empirically discovered A = B and B = C) or of inequalities (A < C if it has been discovered that A < B and B < C); whereas after 7-8 years (for lengths and certain other relations, but only after 9-10 years for weights without indications of volume), this transitive nature henceforth appears "necessary" without having been taught. What, then, is the source of this logical necessity which is neither innate nor socially transmitted (Piaget, 1965, pp.31-32)?

From a psychological standpoint, the structures referred to as the source of intellectual functioning are labelled "concrete operations" by Piaget.

The term "operation" refers to any internalized action, or representation, which belongs to the entire network of actions related to it (Piaget, 1950, p.35). For example, in mathematics, addition is an operation representative of the action uniting certain elements, and part of the whole complex of activities whereby these elements can be joined together and taken apart in a reversible manner.

> The specific nature of operations as compared with empirical actions, depends ... on the fact that they never exist in a discontinuous state ... a single operation could not be an operation because the peculiarity of operations is that they form systems (ibid. p.35).

When operations first become a part of the child's response repertoire they are "concrete" because they deal with concrete, manipulable objects.

To use a mathematical example again, a young child does not perform addition as an abstract possibility, but as a covert action on objects which he can actually see, manipulate or imagine being added and subtracted.

Because a child's actions are now part of a vast network of possible actions, a "mobile equilibrium" (Piaget, 1950, p.141) is reached which is based on the child's grasp of the concept of reversibility.

> If I divide a given collection of objects into four equal piles, I can recover the original whole by multiplying one of my quarters by four: the operation of multiplication is symmetrical to that of division. Thus every rational operation has a corresponding operation that is symmetrical to it and which enables one to return to one's starting point (Piaget, 1966, p.172).

This equilibrium is reached when a child knows that two successive actions can be combined into one (for example, one type of creature can simultaneously be both a cow and an animal), that his actions - overt and covert - are reversible (cows plus other animals are all animals, and all animals minus other animals are cows), that the same point can be reached by two different routes (cows plus other animals are all animals <u>or</u> other animals plus cows are all animals), and that a return to the starting-point finds the starting-point unchanged (for example, the combination of cows and flowers can be annulled by removing the flowers). All these various "transformations" (Piaget, 1950, p.141) are grasped simultaneously because they all constitute part of the general system of operations in which every action is embedded.

The child's increasing accuracy of performance on tests of these structures is determined by factors over which the educator has no control, maturation (Piaget, 1965, p.33) and environmental complexity (Rosenzweig,

1966) being obvious examples. However, Piaget (1965, p.35) lists a formative factor in connection with which the educator's control may be relatively strong. In contrast to mere "physical experience" by virtue of which the attributes of objects are discovered, Piaget describes a "logico-mathematical experience" which is the product of the subject's action on the object. For example, the achievement of concepts in arithmetic results not from objects but from the way they are acted on - added, subtracted, ordered, and so forth.

> In any expression, such as $(x^2 + y = z - w)$, each term refers to a specific action: the sign (=) expresses a possible substitution, the sign (+) a combination, the sign (-) a separation, the square (x^2) the action of reproducing 'x' x times, and each of the values, w, x, y and z the action of reproducing unity a certain number of times. So each of these symbols refers to an action which could be realized, but which mathematical language contents itself with describing abstractly in the form of internalized actions, i.e. operations of thought (Piaget, 1950, p.33).

This is the sort of distinction made by Held (1965) when he writes about adaptation to a distorted visual environment

> movement alone, in the absence of the opportunity for recognition of error, does not suffice to produce adaptation; it must be self-produced movement ... this kind of movement, with its contingent reafferent stimulation, is the critical factor in compensating for displaced visual images (1965, p.87).

The subject's co-ordination of his actions on objects (Piaget, 1965, p.36), then, leads him to the discovery of elementary operations in the form of the logic of classes and the logic of relations among classes. For example, in his experiments with additive classification, Piaget (1964) has chosen to use pictures of flowers and geometric shapes rather than animals because he found that logical thinking seemed retarded when using the latter. He explained that

> children do play about with circles and squares between the ages of 5 and 9; and unless they are city dwellers they often pick flowers or just primulas either in their gardens or when they go for a walk ... but ... a child cannot say that ducks are birds and birds are animals by simply relying on experience drawn from his own actions, as he can for squares and circles which he has drawn and for flowers which he has picked. He is compelled to rely far more on purely linguistic concepts and he may need to structure and develop these in the course of the actual experiment. This explains the time lag (Inhelder and Piaget, 1964, pp.110-111).

To support his contention that language is an unimportant factor in the child's achievement of these concrete operations, Piaget provides an argument and some evidence. The evidence, which is not completely unanimous (Bruner et al, 1966, p.150), comprizes the conclusion from experimental studies that

> verbal exercise is not enough to produce the acquisition of a logical structure when it is not yet constructed operationally ... we observe children of 7-8 years who use certain verbal expressions involving inclusion (for example, "some of my flowers are yellow") but without precisely understanding this inclusion (as if the expression meant "All of my some flowers are yellow"): we must wait until the relation of inclusion is acquired in the operational mode ($A < B$ if $A + A^{I} = B$ and if $A = B - A^{I}$) for the adequate comprehension of verbal expression to be possible (Piaget, 1965, p.35).

The argument is that the sensori-motor correlates of concrete operations, observed in the child's behavior long before he can speak,

> express the laws of the most general coordinations of actions. There is, then, a logic of coordinations of actions, of which verbal logic is only a particular case, and in studying "the child" before the appearance of language, we find, at the purely sensori-motor levels, the roots of this language of coordinations of actions. The system of sensori-motor "schemes" affords, in fact, the beginnings of classifications, of a sense of relationships, reversibilities and reciprocities; and these sensori-motor roots of subsequent logical structures are, from all evidence, independent of verbal behavior (Piaget, 1965, p.35).

At three and four months of age, infants have shown reactions to visual

stimuli, demonstrating their ability to discriminate a particular class of visual cues which pertain to feeding (Piaget, 1963, p.60). Even at such an early age, coordination between two initially independent actions, seeing and sucking, has begun. It is on an hierarchical structure of coordinated or reciprocally assimilated actions, gradually becoming more complex as new assimilations are discovered, that intelligent functioning is based.

The general drift of Piaget's (1950) orientation to the developmental study of intellectual functioning is that verbal behavior, like any other symbolic performance, is

> an action ... which simply replaces things by signs and movements by their evocation and continues to operate in thought by means of these spokesmen (Piaget, 1950, p.32).

and that, therefore, it is necessary

> in order to arrive at the real functioning of intelligence, to reverse this natural movement of the mind and to revert to thinking in terms of action itself; only in this way will the role of this internal action, the operation, appear in a clear light. And this very fact forces us to recognize the continuity which links operation with true action, the source and medium of intelligence (ibid. p.32).

Furth (1966) has accumulated considerable evidence from his research with deaf persons to support the view of nonverbal problem solving (1966, p.16). He hypothesized that language learning among the hearing does not demand a high level of intelligence (retarded children can learn it quite well) and therefore, its lack cannot of itself be the factor which retards problem solving among the deaf. If the deaf subjects were to show an inferior performance to matched hearing controls on a thinking task, there had to be a factor, other than linguistic inadequacy, common to most deaf

persons which related to the inferior performance. Twelve nonverbal experiments were devised in which linguistic competence was not assumed and verbalization was discouraged. Because of the ambiguity involved in nonverbal instructions, transfer-type tasks were used in which the introductory task was very simple, and the principle learned had to be applied to a new, more complex situation. Matched samples of deaf and hearing subjects ranging in age from four to fifty years participated in the research. The areas under study were labelled conceptual discovery and control, memory and perception, Piaget-type conservation, logical classification and verbal mediation.

Tasks designed to test "conceptual control" dealt with concepts of sameness, symmetry, and opposition among deaf, hearing and retarded hearing children, with discovery of similarities and with comprehension of part-whole relationships (ibid., pp.76-97). Pictures were used. For example, the similarities test consisted of eighteen sets with seven pictures in each. In every set, three of the pictures could be put together on the basis of some common principle (e.g. name-fruit or function-writing). Generally, Furth thought that the deaf subjects understood the gestured instructions quite readily (ibid., p.88). Results showed that eight year old deaf children performed less well than eight year old hearing children, but at age sixteen the two groups performed equally well. When required to select pictures illustrating a part-whole relationship, the performance of the deaf subjects closely approximated that of the hearing controls, with I.Q. being a significant factor among the latter, and age being significant for both groups (ibid., pp. 94-95).

To examine the area of memory, subjects were presented with series of written digits and of nonsense figures high and low in verbal association (ibid., p.102). The deaf differed minimally from the hearing on figures, but on digits were consistently poorer. Furth (ibid., p.103) explained that verbal ability possibly helps memory when words are available, but more likely, deaf children have little opportunity to practise memory for numbers (ibid., p.104). High association aided the figure recall of both groups, showing that familiarity rather than verbal association was the significant factor in memory. Perception, tested by reproduction of drawings presented according to Gestalt principles, was found to be basically the same among deaf and hearing subjects. Differences which occurred tended to be along the dimension of different maturational levels rather than between hearing and non-hearing, showing that general nonverbal experience was more important than specific language ability (ibid., pp.112-113).

An interesting development was noted with Piaget-type tasks of conservation. Both with weight and with volume, deaf children were two and five years respectively behind hearing children in grasping this nonverbal logical principle. Furth (pp.117-124), discussing conservation of weight, felt that deaf children have less training in numbers and less general experience of the physical world. The great gap between deaf and hearing in acquisition of conservation of volume he attributed largely to the particular testing procedure employed, in which younger deaf children were not able to understand the basic question.

Logical classification tasks were administered to various age groups

(ibid., pp.126-143). First, a classification transfer task was given to deaf and hearing college students. The task involved responding with the letters A, B, or C to three disjunctive categories. The transfer demanded use of Q, R and S for new disjunctive combinations of the four classes discovered in the first task. It was found that the deaf college students were not as able as their hearing peers to make use of verbal principles, but when concept attainment of a disjunctive class was measured, both groups performed equally well. Grade school deaf children were found to be equally competent to the hearing in comprehension and use of logical symbols, but consistently poorer when required to learn symbols and discover concepts in a rational manner rather than by rote (ibid., pp. 142-143).

The final tests, involving a reversal shift usually identified with verbal mediation, gave results in which deaf people performed remarkably like the controls (ibid., p.161). Twelve hearing and twelve deaf children at each of ages four, five, six, seven and nine were given acquisition trials in which a reward was placed in double alternation fashion behind one of two doors. The success criterion was ten consecutive correct choices. In the first transfer task, the doors were replaced by two blocks and a light went on to indicate the correct response. Three further tasks were given in which changing dimensions to be disregarded by the subject were included as interference. Only at ages five and six did the deaf perform less well than the hearing, with no difference at ages four, seven and nine. Furth concluded

> In a number of areas in which verbal mediation or control has been proposed as crucial, deaf children were observed to do as well as the hearing. While the deaf were often slow in discovering a principle of reasoning - a motivational-intellectual

> characteristic which can be associated with their intellectually restrictive environment - the deaf adults seem to have the ability of hearing persons to comprehend and logically apply principles and concepts (ibid., p.168).

Furth's discussion of his results has a Piagetian flavor.

> Action is the source and medium of intelligence and the reality of concepts must be sought in the action of thinking which can become embodied in a symbolic medium. But human intelligence is neither tied to any particular type of internal images, nor to any particular type of symbols (ibid., p.197).

That is, intelligent behavior occurs independently of language, and thoughts can be symbolized in words or in other symbolic media without being dependent upon these media for their occurrence.

Now for Piaget (1962), the assimilation of input into concrete categories without any consequent accommodation to reality takes place at the subconscious level.

> All assimilation which does not combine with accommodation to form an equilibrium, i.e. which does not result in purposive generalization, takes place unconsciously both in the intellectual and the affective field. ... When in the field of reflective and even scientific thought a new problem is approached by way of uncritical transposition of habits of mind and ideas used in other fields, the assimilation is still largely unconscious. ... even when intelligence is at its most lucid the inner mechanism of assimilation is outside awareness, which first grasps only results and then by recurrent and ever incomplete reflection works back from the outside to a centre which it never reaches (1962, p.208).

Koestler (1964, pp.317-319) has provided extensive documentation for this position from the work of creative writers. Binet (1911), in the continental introspective tradition, has described a new "theory of action", in which

> there exists besides a certain act of comprehension, an interior act, which no image, however clear or definite or detailed, can ever represent; for it is not enough to have a series of images before one's eyes, they must be interpreted, in short, understood;

> and without this necessary addition, nothing is accomplished; and moreover, one can as has been proved, understand without the aid of any kind of image (Binet, 1911, p.46)[1]

Understanding is not an intellectual awareness, but an emotional attitude

> according to which the psychic life is by no means a rational life but a chaos of darkness streaked with flashes of light, something strange and, above all, discontinuous which has only appeared continuous and rational because after the event it is described in a language which puts order and clarity into everything. Yet this is a fictitious order, a verbal illusion, which bears no more resemblance to real life than does the declamation of classical tragedy to the unleashing of passions (Binet, 1911, p.47).

Binet's position is reinforced by Lashley (in Beach et al, 1960, [1949]) who worked in the American experimental tradition.

> Subjective experience reveals only a complex activity, varying from moment to moment, without constant structure or content. The characteristic is the organization. The organizing process is not experienced; that is, thoughts think themselves, just as the words of a sentence fall spontaneously into grammatical order. The elements which are organized, sensations, feelings, etc., cannot be described or defined. They are abstractions from the mental structure which have in themselves no attributes distinguishing them from physical abstractions (Beach et al, 1960, p.457).

Because he was attempting to show that behavior of even the lowest form of animal life differed from human behavior quantitatively, not qualitatively, Lashley equated an organism's "mental state" to the "level of organization of its activities". This organization was seen as independent of language, which to Lashley

> seems to be primarily the expression of forms of relational organization which are absent in lower animals, rather than a means to such organizations, as has sometimes been held (ibid., p.470).

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1 The translations from Binet (1911) have been borrowed from Reeves (1965) pp.247-248.

Lashley's phrase "thoughts think themselves" is remarkably similar to Huxley's (1962) description of what he labels "education at the non-verbal level (p.288)."

This sort of subconscious nonverbal formulation can be translated into Watson's (1928) the "unverbalized". Watson (1928, p.97) notes that we learn to respond to a word as we formerly responded to the object with which it was associated and he proposes that the word 'unconscious' be applied to "... that part of the individual's object world which he constantly manipulates with his hands, feet and body, but does not name or attach a word to ... (1928, p.98)."

Consistent with this translation of Binet into Watson's terms is the overwhelming distaste for language vouchsafed by leading scientists and by traditional empirical philosophers as a medium of precise communication (Anderson, 1958, Koestler, 1964, pp.169-177). As Anderson (1967) has indicated, the intent of the Royal Society's motto "Nullius in Verba" was clearly manifested in Sprat's proposal, published initially in 1667 and reprinted by Cope and Jones (1958), for the general education of youngsters. Sprat (1958 [1667]) contends that

> it is apparent that nothing more suppresses the genius of learners, than the formality, and the confinements of the precepts, by which they are introduced. To this purpose I will venture to propose to the consideration of wise men, whether this way of teaching by practice and experiment would not be at least as beneficial, as the other by universal rules. Whether it were not as profitable to apply the eyes, and the hands of children, to see, and to touch all the several kinds of sensible things, as to oblige them to learn, and remember the difficult doctrines of general arts (1958, p.329).

There are two difficulties about words as a vehicle of problem solving; they are much less speedy than their nonverbal equivalents

(Kubie, 1958, p.24) and they are ambiguous (Freud, 1959 [1910]). As Koestler (1964) concludes, "Language can become a screen which often stands between the thinker and reality (p.177)." This position can be documented easily. Maxwell writes in a letter of 1858, reprinted by Campbell and Garnett (1882) that

> I have observed that the practical cultivators of science (e.g. Sir J. Herschel, Faraday, Ampère, Oersted, Newton, Young), although differing excessively in turn of mind, have all a distinctness and freedom from the tyranny of words in dealing with questions of order, law, etc., which pure speculators and literary men never attain (1882, p.305).

A similar view is held by Hadamard (1945)

> I insist that words are totally absent from my mind when I really think and I shall completely align my case with Galton's in the sense that even after reading or hearing a question, every word disappears at the very moment I am beginning to think it over; words do not reappear in my consciousness before I have accomplished or given up the research, just as happened to Galton; and I fully agree with Schopenhauer when he writes, "Thoughts die the moment they are embodied by words" (Hadamard, 1945, p.75).

Einstein, in response to a question by Hadamard (1945) admits that

> The words or the language, as they are written or spoken, do not seem to play any role in my mechanism of thought. The psychical entities which seem to serve as elements in thought are certain signs and more or less clear images which can be "voluntarily" reproduced and combined (ibid., p.142).

His entities are not unlike Piaget's

> The above mentioned elements are in my case, of visual and some of muscular type. Conventional words or other signs have to be sought for laboriously only in a secondary stage, when the mentioned associative play (see previous quote) is sufficiently established and can be reproduced at will (ibid., p.143).

Clearly, eminent thinkers have found themselves hampered by linguistic imprecision. Reduction of their thoughts to verbal formulation has meant for them, a loss of clarity and accuracy.

This theory implies that there can exist a certain number of taciturn individuals who can engage in all sorts of intellectual pursuits such as problem-solving, creative discovery and so forth without recourse to verbal symbols, the use of which as a result, might be seriously circumscribed because of lack of practice. Other attributes may characterize the members of this group, most obviously, maleness. As Roe (1963, p.133) has pointed out, the teaching in the elementary school is heavily verbal with an emphasis on rote learning to the exclusion of nonverbal problem-solving, a situation which, according to Kuhn (1963, p.350) applies also to the teaching of science in the high school. Such a verbal emphasis will suit the female whose significantly superior elementary school performance (Watson, 1965, p.596), particularly in reading (de Hirsch, 1966, p.46), is matched by an equally superior pre-school verbal performance (Watson, 1965, pp.331-332). Furthermore, competence in beginning reading requires the association of symbol and sound in accordance with the direction of the teacher, the kind of performance more likely to be obtained from the obedient and hard working female (Maccoby, 1967, pp. 27-28) who is receptive to and tends to imitate external moral standards (Lynn, 1962, p.559). The boy, on the other hand, who is markedly superior on tests both of verbal and nonverbal problem solving (Lynn, 1962, p.561) and on the heavily nonverbal tests of spatial performance (Maccoby, 1967, p.26; Smith, 1965, pp.209-210), performs less well at school because he internalizes his own moral standards rather than being highly responsive to those of others, i.e. his teachers (Lynn, 1962, p.559).

Finally, the taciturnity of Couch and Keniston's (1960, pp.1967-68) "naysayers", as compared to the talkative and impulsive "yeasayers", is associated with their greater acceptance of socializing pressures by parents (ibid., oo.171-172), i.e. their greater conditionability if Eysenck (1964, p.80) is correct. An appropriate test of ease of conditioning has been devised by Uznadze and used by Herzog (1967) and Hritzuk (1967). It is based on the theory that repeated presentations of the same stimulus establish a set in the subject which is said to be fixated when it causes the learned response to be elicited in a similar situation. The number of presentations of the stimulus before set can become fixated varies among individuals, depending upon their sensitivity to conditioning, as does the number of trials needed to extinguish it. A number of Georgian psychologists from Russia have done research in the area of set. The following account of the Russian work has been summarized from Hritzuk (1967). Norakidze (1966) noted that behavior in impulsive people is conditioned by the type of sets that are prevailing at any given moment - it is determined by situational factors and not by any principles or goals within the individual. Uznadze (1966) found, as did Eysenck, that impulsive people do not condition well, possibly because they orient to many different aspects of any situation (Pribram, 1964, pp.87-88) and their set, once established, is easily extinguished.

> we may note the presence of a completely distinctive group of subjects who ... never fall under the influence of the fixing experiments, never fix the set which arises in each individual case, and therefore always give the correct estimate of the size of the experimental objects.[2]

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2 Set tests are described on Pp. 21, 27, 28, of the present paper.

> ... the usual number of fixing exposures is inadequate for the production of a fixed set in these subjects, so that a new set arises as a result of each individual exposure, ... we are dealing with persons lacking in internal directing power, and apparently entirely under the control of outside impressions, and thus, distinguished by their extreme extraversion (Uznadze, 1966, p.49).

Now the number of these male (female), taciturn (chattering) and easily conditioned (conditioned with difficulty) individuals will be small for the simple reason that performance on tests of verbal and nonverbal skills are correlated significantly and to a moderately high degree (MacArthur and Elley, 1963). Accordingly, the existence of a factor sustained by the discrepant performance of subjects (high reading, low problem-solving and vice versa) is best demonstrated by using the scores of a biased sample of subjects to test the hypothesis that the relationship between a factor comprizing tests of Piaget's concrete operations and one comprizing tests of competence in beginning reading will be markedly lower than the moderately high relationship observed between verbal and nonverbal factors as determined from standard intelligence tests, and that tests of taciturnity and conditionability will show a heavy loading on the nonverbal factor.

The efficacy of the biasing was checked by determining whether the WISC nonverbal IQ and verbal IQ were heavily loaded on the Piaget and reading factors respectively.

An apparent difficulty in the way of this theorizing is that the Russian impulsivity seems to be the inverse of Kagan's (1964)(1965a)(1965b)(1966) impulsivity, defined as the attempt "to solve every problem by following through on the first idea that occurs to him (the child)

(Kramer, 1967, p.75)."[3] Furthermore, Kagan (1965b) has demonstrated that impulsivity is correlated significantly with word errors in reading. Some examples of the errors involved are meaningful substitutions of words (e.g. "thin" for "thick", Wednesday" for "Tuesday", "a" for "the"), non-meaningful substitutions of words which have neither phonetic or semantic similarity to the original, or partial identity substitutions in which the word read has some similarity to the one written (e.g. "nose" for "noise", "truck" for "trunk", "upon" for "upward") (ibid., pp.620-621). However, Kagan's "reflective" is a global category emphasizing long delays before reporting a solution which when given is usually correct.

> The reflective child considers the differential validity of alternative answers, makes fewer errors in reading prose or in recalling serially learned material, and persists longer with difficult tasks. ... wants to avoid making an error and inhibits potentially incorrect hypotheses (Kagan, Pearson and Welch, 1966, p.583).

It includes, that is, attributes other than the three mentioned previously and it excludes taciturnity and conditionability. Consequently, Kagan's findings can be accepted without damaging the theory.

In short, then, the main testable hypothesis arising from the theory is that intellectual functioning at a conscious level can be verbal or nonverbal. Although frequently competence in one mode is accompanied by competence in the other, certain individuals will be found whose problem solving ability will be predominantly nonverbal. These individuals will tend to be male, taciturn and easily conditioned. Because of their presence, the relationship between tests of Piagetian concrete operations and reading will be lower than that between verbal and nonverbal factors

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[3] This definition is derived from Kagan (1964, 1965a, 1966).

as usually measured on intelligence tests. On the other hand, those who perform well on a test of beginning reading will tend to be chattering females and difficult to condition.

CHAPTER III

METHOD OF INVESTIGATION

The sample

Fifty-one subjects were tested. All were in the first grade of a suburban elementary school in Edmonton, Alberta. The school is in a middle class area, and the achievement of its pupils is generally considered to be above average. The sample included twenty-seven subjects (19 males and 8 females) from one class and twenty-four (15 males and 9 females) from another. Children had been randomly assigned to these two classes at the beginning of the school term. Ages ranged from six years three months to seven years two months, with the median and mean age at six years eight months.

The tests

1. To establish the reading criterion, the Lee Clark First Reader Reading Test, Form A, was used. This group test was administered by each teacher to her own class, and was scored by the teachers. The five subtest purport to measure both what was previously defined as "perceptual" skills (choosing the written words from auditory and visual stimuli) and "conceptual" skills (following directions, sentence completion, making inferences). However, because the responses to the latter sort are multiple choice, it is possible to assume that children who have acquired reading skills at a perceptual level only may perform well on these subtests simply by choosing the word which is most familiar. The word they know and recognize is usually the correct choice, and the chances are good that it will be preferred over the alternatives even without involving the conceptual or "thinking" abilities expected by the test manufacturers.

2. Three Piagetian tasks were administered to determine the children's level of performance in concrete operations. First, addition tasks were adapted from Piaget's experiment with flower pictures (Inhelder and Piaget, 1964, p.101). Since logical addition is followed by acquisition of logical multiplication, two multiplicative operations were required, one based on matrix tests (ibid., p.159), the other on class intersection (ibid., p.176). Although Piaget refers to the former as "complete multiplication" and the latter as "simple multiplication", he feels that the intersect is a more complicated process which involves abstracting a portion of the total system of the matrix.

3. A set test was administered in the haptic modality, using three wooden spheres with handles. One sphere was 100 mm. in diameter, the other two were each 70 mm. in diameter, and each of the three spheres weighed 300 gm. (Herzog, 1967).

4. A test to measure impulsivity-reflectivity was devised, based on Kagan's (1964) matching Familiar Figures (MFF). Twelve charts 8.1/2" x 11" were made, with seven simple ink drawings on each. The top picture, the stimulus, had to be matched perfectly with one of the six alternatives drawn below. The other five pictures had slight variations. Two of the charts served as samples and ten were test items.

5. Verbal and performance IQ scores were obtained from the Wechsler Intelligence Scale for Children (WISC) which the author administered, following standard instructions, to each subject. The digit span subtest standard scores were used as a measure of immediate memory and freedom from distractibility.

6. A taciturnity measure was calculated by imposing a normal five-point scale on the teachers' rating of the students in order from the most talkative to the least. The ordering made by the teachers corresponded closely to that which would have been made by the author as a result of the individual testing interaction with each student, with the extremes being identical. That is, the children considered most talkative by the teachers would have been classified in the same manner by the author, and vice versa. The most taciturn were classified as 5 and the least were 1.

Procedures

1. Classification tests

For the addition tasks 20 pictures were used, 16 of which represented flowers and 4 represented "other things" (a bonnet, a banana, a horn and a fish). Among the flowers, 8 were tulips, 4 of them being yellow and 4 of different colors. Following Piaget (Inhelder and Piaget, 1964, p.101), the following class inclusion relationship could be established.

A (yellow tulips) $<$ B (tulips) $<$ C (flowers) $<$ D (flowers and other things)

Problems were formulated as follows:

(1) For spontaneous classification, the twenty cards were lying in a random order before the child who was given these instructions:

> Here I have some cards with pictures on them. The pictures are all mixed up. I want you to put them in bunches that you think belong together - groups that go together.

If a child seemed unduly hesitant about a particular picture, he was asked

> What is that picture?

and then

Well, then, where does it go?

Encouraging but non-directive comments were made if the child seemed unable to continue. Verbalization was neither encouraged nor discouraged, and few of the children spoke unless questioned. A limit of five minutes was put on the spontaneous classification test.

(2) To determine comprehension of class inclusion, the picture groupings were placed correctly on the table and the child was asked

> Here is a garden. If you pick all the tulips in the garden will you pick this one? (pointing to a red one)

(3) Finally, to check whether the child understood quantification of inclusion, the following questions were asked:

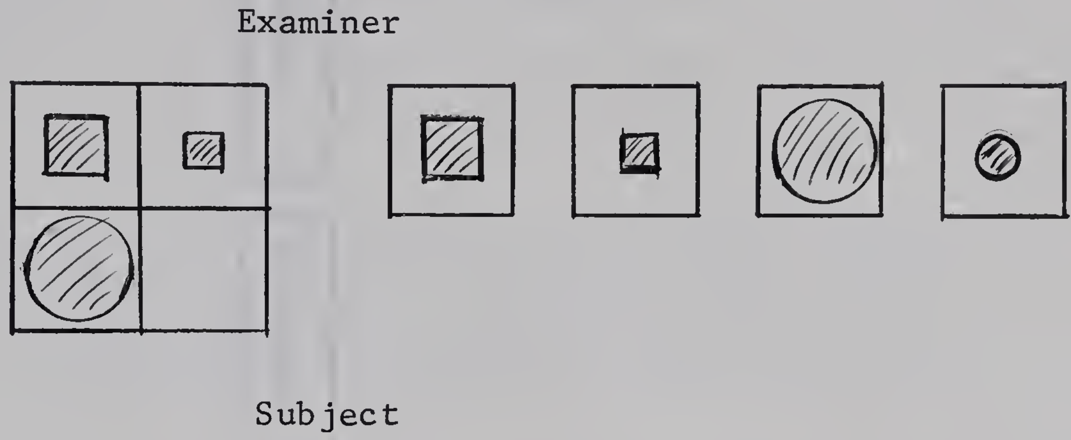
> (a) Are there more yellow tulips or more tulips altogether in the garden?
>
> (b) Are there more tulips or more flowers altogether in the garden?
>
> (c) If you pick all the tulips, will there be any flowers left?
>
> (d) If you pick all the flowers, will there be any tulips left in the garden?

The word "altogether" in questions (a) and (b) was not used in the Piagetian experiment, but it was inserted here because children who did not understand quantification of inclusion were not assisted by it, and it clarified the question for those who did (e.g. some adults who were asked the questions, as well as several older children). If the child was not responding to questions (c) and (d), he was encouraged to perform the action:

Go ahead the pick all the tulips

OR Go ahead and pick all the flowers.

The matrix tasks were also based on ones used by Piaget (ibid., pp.160-161). The sample card was presented to each child in this manner:



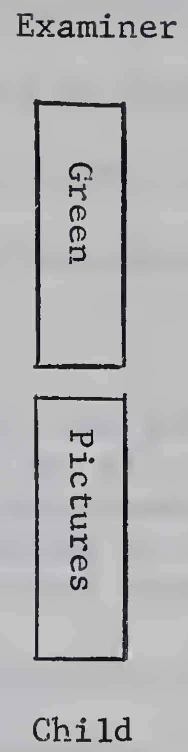
Look, here is a big green square and here is a big green ball. Here is a little green square, but the last picture is missing. Find the missing picture and put it in the right place. (Pause until child located the correct one - he was helped if necessary). That's right - look we have a big green square and a big green ball, a little green square and a little green ball. Or looking this way, we have a big square and a little square, a big ball and a little ball.

Then the next 5 item cards and choices were laid down in front of the child. Each time, the examiner said,

Now look at all of these shapes (or pictures) and find the right one for this space.

After the child made his selection, the reason for his choice was elicited and recorded.

Simple multiplication (intersect) problems were administered in a manner similar to that used by Piaget (ibid., pp.176-178). Two cards with green pictures were placed before the child, perpendicular to his position.



In what way are all these pictures the same?

If the response was incorrect the child was told the pictures were all green and was asked

> Now, if I make a space here in the middle for one more picture, what sort of picture will go with all the others?

A correct response here was credited with a point; but a child who was unable to answer was eventually given the correct answer.

The green pictures were removed, two cards with various colored leaves were placed parallel to the child, and he was told

> All these pictures are the same. How are they the same? Yes, (or no), they are all leaves.

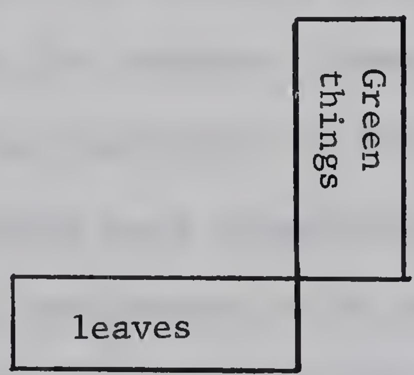
The question was asked

> If I make a space for one more picture here in the middle, what picture must I put in so it will go with <u>all</u> the others?

Again, the correct response received a point, and a wrong one was corrected. Then the two sets of pictures, the greens and the leaves, were placed in the form of a cross, with a space left in the centre. Six alternatives were given from which to choose the correct picture for the space.

> Now I'm going to put all the green things here and leave a space and I'm going to put all the leaves this way. We have to find a picture for this space. Remember, it has to go with all of these (pointing to the green things) and all of these, too (pointing to the leaves).

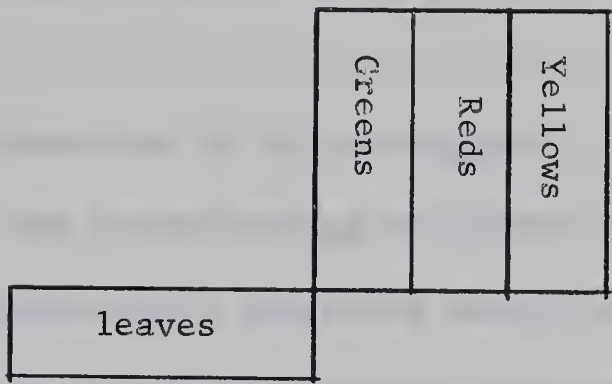
After the child made his selection, he was asked to give a reason for his choice, this was recorded verbatim. The chosen picture was replaced in its original position among the alternative pictures, and the cross shape was modified to this:



The examiner then asked

> Now can you tell me which picture goes with this (pointing to the green things) and this (pointing to the leaves)?

The child was questioned regarding the suitability of his choice and his answer was recorded. Then the green row and green alternative pictures were replaced by red ones, and the same method of questioning as with the greens was used. The reds were replaced by yellows, and again the same method was employed. Finally the child was presented with this stimulus



and asked

> Now, can you find <u>three</u> pictures, one that goes with this and this (pointing to greens and leaves), one that goes with this and this (pointing to reds and leaves), and one that goes with this and this (pointing to the yellows and leaves)?

The child was required to complete the three columns correctly and once again explain why he chose the pictures he did.

Scoring was done by the examiner. Generally the scores were based on two factors, the correct selection of the answer and some indication that the operations involved were understood. The latter was based on relevant verbalizations, spontaneous or in response to questioning. Total score for each of the subtests (addition, matrix and intersect) was 12 with a total possible score of 36.

2. Set test

(a) Fixation of set

Each subject was blindfolded and seated on a chair with his hands, palms upward, resting on his thighs. He was told

> I am going to give you two balls, one in each hand. You may hold them for a moment, then I'll take them away. I'll do this a few times. Every time I give you the balls, you tell me if they are the same size or if one is bigger.

Unless the child responded quickly on his own, after each presentation he was asked

> Are they the same size or is one bigger?

to make certain he was concentrating on volume not on weight.

The unequal spheres were presented twice, the larger one always in the right hand. Then equal spheres were substituted. This was the critical test, the test for set. If the equal spheres appeared unequal, the set had been fixated, if not, the setting trials were resumed. Critical tests were made after every third setting trial until the set was fixated, or to a maximum of seventeen setting trials.

(b) Extinction of set

After set was established, the critical trials (presentation of equal spheres) were continued until the spheres were perceived as equal for five consecutive trials, or up to a maximum of forty critical trials.

3. Matching Familiar Figures (MFF)

Each subject was first shown Sample A chart and told

> Look at the picture at the top. Can you find one just like it here? (pointing to the other pictures)

When the correct one had been located, the procedure was repeated with Sample B until the answer was found. Then the examiner said

> I will show you ten more cards. Each time I show you a card, look at the top picture first and find one exactly like it. I am going to use the stopwatch to see how long it takes you to find the correct one, but you may take as much time as you need to make sure. Only <u>one</u> of the pictures is exactly like the top one.

The ten charts were presented in order with no further instructions. Each response was scored and the time in seconds was recorded.

Analysis of the Data

Pearson Product-moment correlations were calculated between seventeen variables. The matrix of intercorrelations was then subjected to principal axis factor analysis according to Householder's method. Rotations were carried out on the first six factors, first according to the Varimax criterion for simple structure, and subsequently according to the Procrustes method, in order to obtain the best possible approximation to a factor completely defined by the nonverbal tests. The Procrustes technique involves rotating the factor matrix to the best possible fit to a hypothesized factor structure, and does not necessarily produce orthogonal factors. In the present case, the hypothetical factor structure to which the best possible fit was sought involved a first factor deriving all its variance from the reading tests and a second factor completely defined by nonverbal tests, including those of Piagetian concrete operations. A second Varimax rotation was performed on the first two factors only to increase the size of loadings of certain variables other than the main ones defining the second factor.

CHAPTER IV

RESULTS

The mean and standard deviation of performance on the WISC verbal and nonverbal IQ scores were calculated and found to be as follows: verbal mean 108.43, standard deviation 10.52, nonverbal mean 112.41, standard deviation 11.38. The matrix of intercorrelations among seventeen variables is shown in Table 1.

Six factors with latent roots greater than one were obtained by the method of principal axes. Table 2 shows these factors rotated according to the Varimax criterion.

In the case of the orthogonally rotated factor matrix, the first factor was defined primarily by the scores in reading. It was characterized by high loadings of all the reading subtests, and a moderately significant (not statistical significance) loading of Piagetian additive classification. Some loadings, approaching significance, of WISC verbal and digit span were also noted on this factor. The greater part of its variance however, 82.7%, was derived from reading tests which probably measured verbal and visual memory, a perceptual skill. The second factor in the orthogonal matrix was defined by the scores for Piagetian matrix and intersect tests, WISC performance, and a slight loading of Piagetian additive classification. The matrix, intersect and WISC nonverbal accounted for 79.8% of its variance. Set tests, both setting trials and, inversely, critical trials, comprised the third orthogonal factor, contributing 86.4% of its variance. Factor, four the sex factor, took much of its variance from that variable, with digit span making a

negative contribution, and age a moderate positive one for a total of 92.4%. In other words, a low digit span score was associated with males, particularly those who were older. Lengthy response time on the Matching Familiar Figures Test accounted for a good deal of the variance in the fifth factor, in association with low verbal WISC IQ, and some contribution from older children, particularly females, comprising 90.8% of the variance. Finally, the only significant loading on the sixth factor was taciturnity, making a 65.2% contribution to the total variance of that factor.

It is clear from these results that the hypothesis must be rejected because the nonverbal factor loadings of the spheres and taciturnity tests are negligible.

In an attempt to increase the size of the loading for taciturnity and spheres set tests on the second factor, another Varimax rotation was performed on the first two factors only (latent roots 4.431 and 2.056). The results which appear on Table 3 showed a reduced contribution of the Intersect subtest on the nonverbal second factor and increased loadings of verbal WISC, sex, and setting trials of the spheres test, with significant negative loadings of spheres test critical trials and taciturnity. That is, there was a tendency for nonverbal performers to be talkative males who were difficult to condition and quick to lose their set. This finding, which invalidated the current hypothesis, supported Kagan's (1965b) discovery that verbal, impulsive boys are poor beginning readers. It also demonstrated that despite the definition of impulsivity cited previously, the main characteristic of Kagan's impulsive subjects is like

that of the Russians, i.e. they are difficult to condition.

In order to prevent the charge that the overall Varimax rotation artificially destroys any relationships existing between the factors, it was decided to subject the six principal axes factors to an oblique (Procrustes) rotation. The loadings appear in Table 4.

These results, which only sharpen and more clearly define the factors, together with the absence of any intercorrelations among them, as shown in Table 5, once again provide no support for the hypothesis that a relationship exists between taciturnity, conditionability and nonverbal problem-solving ability.

TABLE 1. CORRELATION MATRIX

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.	13.	14.	15.	16.	17.
1. READING Auditory Stimuli	1.00	.641	.691	.710	.635	.384	.061	.064	.324	.243	.274	.168	.019	-.026	-.292	.038	-.066
2. Visual Stimuli		1.00	.685	.639	.612	.437	.197	-.016	.310	.250	.243	.031	-.061	.089	-.186	.097	.048
3. Following Directions			1.00	.624	.578	.368	.027	-.009	.219	.174	.188	.266	.130	.082	-.322	.115	-.150
4. Sentence Completion				1.00	.677	.327	-.033	-.152	.379	.017	.310	.124	.121	-.103	-.241	-.006	-.023
5. Making Inference					1.00	.462	.126	.040	.289	.241	.424	.026	.070	-.044	-.247	.089	-.019
6. CLASSIFICATION Addition						1.00	.298	.119	.199	.192	.069	-.013	.050	-.013	-.043	.013	-.042
7. Matrix							1.00	.194	.260	.554	-.197	.038	-.128	.003	-.045	-.002	-.010
8. Intersect								1.00	.009	.228	-.093	-.021	-.034	.072	-.038	.103	-.030
9. WISC Verbal									1.00	.261	.188	.207	-.154	-.203	-.019	-.018	-.145
10. WISC Performance										1.00	.025	.172	-.175	.057	.052	.027	-.213
11. WISC Digit Span											1.00	-.247	-.155	-.028	-.094	.211	-.028
12. Sex												1.00	.165	-.149	.116	-.193	-.063
13. Age													1.00	.189	-.094	.092	-.059
14. MFF Time														1.00	-.018	-.014	.075
15. SPHERES Setting Trials															1.00	-.628	-.259
16. Critical Trials																1.00	.159
17. Taciturnity																	1.00

TABLE 2. ROTATED FACTOR MATRIX - ORTHOGONAL FACTORS

VARIABLE	I	II	III	IV	V	VI	h^2
1. READING							
Auditory Stimuli	.839	.058	.089	.038	-.096	.081	.733
2. Visual Stimuli	.835	.160	-.009	-.100	.018	-.143	.753
3. Following Directions	.821	.005	.149	.193	.050	.148	.759
4. Sentence Completion	.855	-.206	.018	.033	-.169	.000	.804
5. Making Inference	.819	.077	.100	-.151	-.049	.063	.716
6. CLASSIFICATION							
Addition	.549	.342	-.017	-.005	.092	-.117	.441
7. Matrix	.084	.818	-.047	.080	-.104	-.212	.740
8. Intersect	-.084	.546	.224	-.001	.177	.208	.431
9. WISC Verbal	.372	.242	-.064	-.003	-.586	.108	.556
10. WISC Performance	.193	.770	-.059	-.011	-.114	.211	.691
11. WISC Digit Span	.360	-.222	.140	-.678	-.144	.249	.741
12. Sex	.146	.026	-.145	.762	-.304	.103	.727
13. Age	.107	-.248	.221	.544	.446	.239	.673
14. MFF Time	.073	.114	-.079	-.076	.815	-.029	.695
15. SPHERES							
Setting Trials	-.259	.006	-.826	-.025	-.005	.237	.807
16. Critical Trials	.005	.054	.900	-.148	-.017	.000	.836
17. Taciturnity	-.028	-.115	.191	-.030	.068	-.864	.803
Sums of Squares	4.204	1.954	1.727	1.445	1.431	1.145	11.906
% of Total Variance	24.7%	11.5%	10.2%	8.5%	8.4%	6.7%	70.0%
% of Common Variance	35.3%	16.4%	14.5%	12.1%	12.0%	9.6%	100.0%

TABLE 3. ROTATED FACTOR MATRIX - TWO ORTHOGONAL FACTORS

VARIABLE	I	II	h^2
1. READING Auditory Stimuli	.843	.084	.717
2. Visual Stimuli	.815	.096	.674
3. Following Directions	.813	.021	.661
4. Sentence Completion	.824	-.057	.682
5. Making Inference	.833	.028	.694
6. CLASSIFICATION Addition	.543	.221	.344
7. Matrix	.145	.602	.383
8. Intersect	.007	.243	.059
9. WISC Verbal	.428	.415	.355
10. WISC Performance	.259	.625	.498
11. WISC Digit Span	.418	-.281	.254
12. Sex	.101	.397	.168
13. Age	.061	-.241	.062
14. MFF Time	-.017	-.131	.017
15. SPHERES Setting Trials	-.429	.512	.446
16. Critical Trials	.225	-.506	.307
17. Taciturnity	-.022	-.408	.167
Sums of Squares	4.397	2.090	6.487
% of Total Variance	25.9%	12.3%	38.2%
% of Common Variance	67.8%	32.2%	100.0%

TABLE 4. ROTATED FACTOR MATRIX - OBLIQUE FACTORS

VARIABLE	I	II	III	IV	V	VI
1. READING Auditory Stimuli	.833	.031	.039	.038	-.026	.047
2. Visual Stimuli	.848	.140	-.078	-.096	.130	-.167
3. Following Directions	.830	-.028	.086	.174	.097	.107
4. Sentence Completion	.897	-.230	-.046	.039	-.111	-.048
5. Making Inferences	.808	.044	.042	-.159	.037	.038
6. CLASSIFICATION Addition	.534	.334	-.057	-.002	.185	-.122
7. Matrix	-.025	.852	.008	.130	-.031	-.176
8. Intersect	-.194	.537	.257	-.020	.186	.240
9. WISC Verbal	.288	.254	-.007	.059	-.547	.109
10. WISC Performance	.061	.769	-.010	.007	-.029	.248
11. WISC Digit Span	.337	-.272	.107	-.702	-.093	.246
12. Sex	.149	.054	-.102	.803	-.349	.075
13. Age	.165	-.274	.166	.479	.373	.201
14. MFF Time	.147	.076	-.186	-.165	.890	-.023
15. SPHERES Setting Trials	-.193	-.001	-.831	-.038	.094	.264
16. Critical trials	-.112	.051	.937	-.148	-.137	-.006
17. Taciturnity	.037	-.062	.167	.020	.040	-.879

TABLE 5. CORRELATIONS BETWEEN FACTORS

	1.	2.	3.	4.	5.	6.
1. Reading (Verbal)	1.00	.1793	.1539	-.0489	-.1587	.1180
2. Nonverbal		1.00	-.0501	-.0842	-.0866	.0258
3. Set			1.00	.0111	.2334	.0095
4. Sex				1.00	.1961	.0951
5. MFF Time					1.00	.0005
6. Taciturnity						1.00

CHAPTER V

DISCUSSION

Consideration of the unrepresentative quality of the sample may save the theory for another day's testing in which the verbal and non-verbal factors may not be so clear cut - the correlations between verbal and nonverbal WISC scores was unusually low at .261 and those between reading scores and Piagetian concrete operations were even lower (ranging from .009 to .197) - but the taciturnity and spheres factors might load more significantly on the nonverbal factor, in one direction if Kagan's hypothesis is correct, in another if the hypothesis from the present theory is correct. There is no reason to suppose that Kagan's position is necessarily incompatible with the present one. There are talkative and impulsive boys as well as taciturn and easily conditioned ones, as Couch and Keniston (1960) showed. Perhaps a larger sample would allow the appearance of a sufficient number of the latter sort to influence the correlations. Certainly individuals of this sort did make their presence felt to the investigator during the individual testing[4]. Information about William T., John L., Barbara H. and Jacqueline M. appears in Table 6.

Case 1. William T.

William is the son of recent immigrants and English is not spoken at home. He scored a verbal WISC IQ of 100 but his nonverbal IQ was above the mean at 120. In reading his score was the lowest in his class, and he was driving his teacher to distraction because he "can't think." What she actually meant was that he is unable to give adequate verbal responses to verbal questions, and assimilate various bits of verbal

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[4] However, their scarcity may be due to the possibility that this behavior is characteristic only of relatively creative individuals.

information. He was one of the most taciturn children tested. As predicted by the factor analysis, his score in additive classification was also below average, but his scores in matrix and intersect were at the mean and better. He fixated set on the second trial and maintained it for thirteen critical trials, which put him in the high excitability low extinction group according to Uznadze (Herzog, 1967). Although he scored below average on the MFF response time, it has been shown that because of the excessive difficulty of the test this score is not valid, and cannot be treated as an indicator of impulsivity.

Case 2. John L.

A similar set of scores can be seen in the case of John. The reading total was well below average, in fact, second lowest in his class, with the verbal IQ also below the mean, and performance IQ at the mean. The addition subtest was at the mean, but matrix and intersect, purely nonverbal problem solving, were well above average. In this case also, only two setting trials were required to fixate the set which was not extinguished even after forty critical trials. This is another good example of an unsuccessful student whose problem solving ability is not being used and about whom the teacher exclaims, "He just won't listen!"

There is no necessary reason why females should not occasionally appear in the taciturn and easily conditioned category, as the following case shows.

Case 3. Barbara H.

The case of Barbara was somewhat unusual in that here was a female

nonreading problem-solver. Barbara scored high on taciturnity, established set in slightly fewer than average trials and maintained it for more trials than the average. Her verbal IQ was 100, i.e. below average for this group, but her nonverbal was 128, with matrix and intersect also above average. Her reading was low. Barbara has two older brothers, both of whom have speech defects. Although she herself spoke fluently, she appeared unaccustomed to the usual feminine verbal exuberance. Her taciturnity and reflection may be influenced by the older brothers' inability to speak well, and the consequent emphasis in the home on nonverbal problem-solving and careful analysis of problems. Actually, Barbara was one of very few subjects who made few errors on the MFF (only 4 errors out of 10 problems) with an average time of 57.0 seconds per picture. Her teacher found her frustrating because she worked very slowly and never completed her work.

One case serves to illustrate the cell containing those individuals who read well and don't think.

Case 4. Jacqueline M.

Jackie scored perfectly on the reading test. She also scored 125 verbal IQ, as opposed to 100 Performance, and scored perfectly in Additive Classification responding correctly to all twelve questions, but performed less well on the nonverbal matrix, and below average on intersect. Although she fixated set on the first trial, she also lost it after only four critical trials, which is far fewer than the mean. She scored low on taciturnity (meaning she was rather talkative) and responded very quickly to the MFF. Her teacher considers her an ideal student.

In addition to a more representative sample, other changes would allow the present hypothesis to be falsified with less question. A more rigorous technique ought to be used to measure taciturnity and verbality. Again, the impulsivity-reflectivity dimension would be more validly measured by the MFF devised by Kagan himself - the pictures used in this study had too much detail and young children were not able to focus their attention on the many aspects of each to find the one identical to the stimulus, making the responses of most children little better than random choices. Consequently, impulsivity was measured by using response time only, discounting error scores. This practice discriminated merely between slow and rapid answers, regardless of the reason for delay, which may have been due to reflection, to distraction or to some other cause.

If teachers were aware that the quiet individuals who seem unable to learn have the capacity for problem-solving but are handicapped when it comes to memorization of verbal facts, perhaps for these students at least the emphasis in education would be shifted from a verbal, rote memory sort of learning to education in the solution of problems. One area that lends itself particularly well to a problem-solving approach is science, yet even here, as discussed previously, the focus is more on rote memory than empirical and deductive thinking. One reason for this method of teaching is evident when one considers that relatively few teachers receive special training for science instruction. Only fifty-eight students from among all those in four undergraduate years and in programs for advanced diplomas reported science as their major field of study in a 1966-67 student survey in the Faculty of Education,

University of Alberta. From those fifty-eight, two were in secondary education, the remainder in elementary (Hunka, 1966, p.7). Since science is on the curriculum, however, someone has to teach it, and most frequently someone whose orientation and training has been in languages, the humanities or the social sciences. This person teaches science using methods which may be adequate for students learning French vocabulary and conjugations, but which do not train problem-solving, either verbal or nonverbal.

By the same token, the children who are successful students, can read, memorize and obey, quite likely find themselves, at some point during their lives, inadequately prepared for dealing with new problems for which they have not acquired a memorized response or which lack a set of verbal instructions. These children, too, have been neglected. Their education has prepared them for little except the unimaginative routine of a daily existence in which any novel event or unexplained phenomenon is a source of threat to their status rather than stimulation for their problem-solving, creative potential.

TABLE 6. MEANS, STANDARD DEVIATIONS and CASE STUDY DATA.

VARIABLE	MEAN	STANDARD DEVIATION	WILLIAM T.	JOHN L.	BARBARA H.	JACQUELINE M.
Reading Total	49.98	8.96	32.0	35.0	39.0	59.0
Age in Months	79.71	3.53	75.0	81.0	77.0	76.0
WISC verbal IQ	108.43	10.52	100.0	103.0	100.0	125.0
WISC Perform IQ	112.41	11.38	120.0	113.0	128.0	100.0
WISC Digit Span	12.49	2.14	10.0	11.0	12.0	12.0
CLASSIFICATION Addition	8.55	2.15	3.0	8.0	8.0	12.0
Matrix	8.33	2.95	8.0	10.0	10.0	10.0
Intersect	6.24	3.95	8.0	12.0	11.0	4.0
MFF Average Time in seconds per card	19.14	10.93	11.8	17.5	57.0	10.4
SPHERES Setting Trials	5.63	6.70	2.0	2.0	5.0	1.0
Critical Trials	18.82	16.57	13.0	40.0	27.0	4.0
Taciturnity	3.00	.66	4.0	3.0	4.0	2.0

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